R(OYAL) GLENN HALL, 1921–2004

R. Glenn Hall died on 25 June 2004 following a battle with prostate cancer. His contributions to the determination of the frequency corresponding to an energy level transition in the Cesium atom led to the definition of the length of the second and formed the basis for precise modern timekeeping.

Glenn was born on 23 June 1921 in Koloa, Hawaii, and together with a brother and three sisters, grew up in Albion, Michigan. His father was a professor of political science at Albion College.

He graduated from Park College in Parkville, Missouri with a degree in mathematics in 1941. He served as a corpsman in the U. S. Navy during World War II, and went on to earn a PhD at the University of Chicago in 1949.

Glenn joined the faculty at the University of Chicago as an instructor from 1949 through 1952 and became a research associate there in 1953. While at the U. of Chicago he worked extensively on mass ratios of binary stars, binary star orbits and the determination of stellar parallaxes.

In 1953 Glenn came to the U. S. Naval Observatory (USNO) where he became the Assistant Director of the Time Service Division. His early work at the Naval

Observatory was related to the determination of Ephemeris Time (ET) from photographic observations of the Moon with respect to background stars. This work provided a time scale more uniform than that based on the Earth's rotation, which was the internationally accepted time scale at the time. As a result, the International Astronomical Union in 1955 redefined the second to be the second as determined from Ephemeris Time.

In June 1955, L. Essen and J.V.L. Parry placed in operation a Cesium beam atomic standard at National Physical Laboratory in Teddington, England. Wm Markowitz (1907-1998), the director of the Time Service, and Hall together with Essen and Parry then began the work leading to the determination of the frequency of the Cesium atom in terms of the second of the seasonally corrected time scale determined from the Earth's rotation and also in terms of Ephemeris Time. The former was accomplished using the observations of stars with the Photographic Zenith Tube (PZT) and the latter from the photographic observations of the Moon.

These same investigators later calibrated the frequency in terms of the ET second using observations made with the USNO dual-rate Moon camera over the period 1955.50 to 1958.25. In a paper published in *Physical Review Letters* in 1958 the cesium frequency was found to be 9 192 631 770 Hz with a probable error of ±20 Hz. In 1967 the 13th General Conference on Weights and Measures adopted the atomic second as the unit of time in the International System of Units. It was defined as "the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium 133 atom" The second of atomic time, the basis for all modern timekeeping, therefore, is in principle equivalent to the second of Ephemeris Time.

Glenn went on to lead an international program of Moon-camera observations for the International Geophysical Year in 1957-58 that was extended into the 1960's. His other work at the U. S. Naval Observatory was concerned with the operation of programs using the Danjon astrolabes and PZTs to determine the variations in the Earth's rotation. He also worked with Markowitz to investigate improvements in electronic time transfer techniques using artificial satellites and Loran-C. Other investigations were concerned with the calibration of Hydrogen masers and the formation of time scales.

Hall was a member of the American Astronomical Society and the International Astronomical Union. He retired from the USNO in 1982, and enjoyed an active retirement. He traveled widely, often returning to Hawaii, and pursued his many hobbies: he was an avid bridge player; he had a long interest in stamp collecting and maintained a large garden.

In 1943 he was married to Mary Mowry. They had three children. A daughter, Anne preceded him in death in 1997. His wife and two sons, Thomas, and Robert, and two grandchildren, Garrett and Tarek, survive.

Glenn's scientific work was characterized by a clear analytical sense in the treatment of data. He possessed an ability to recognize systematic phenomena in time series data that

were not always evident to his colleagues. This quality together with his friendly, unflappable nature made him a key individual at the Naval Observatory where he could always be approached for his friendly technical advice.

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